This guide is intended to provide information on most aspects of graduate education in the Mechanical Engineering Department at AUB.
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<td>3</td>
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Information in this guide is subject to change without notice. Students are responsible for checking their AUB email for announcements, information, and updates.

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1>> Graduate Programs

1.1>> Introduction
Welcome to the Department of Mechanical Engineering at the American University of Beirut. We wish you success at every stage of your academic journey. This manual is intended to familiarize you, as a graduate student in the Department of Mechanical Engineering, with the requirements, policies, and procedures you need to understand as a graduate student. The rules and regulations provided in this handbook govern our academic programs and describe the duties and responsibilities of graduate students in the department. These rules and regulations, developed through the years have proven to be beneficial to both students and faculty in the department. In addition, this manual provides useful information and resources to ease and enhance your experience in the department. Each student is expected to be familiar with the contents of this manual. If the answer to a question cannot be obtained from this manual the answer should be sought by asking: the graduate student advisor, or the chair person of the Mechanical Engineering Department preferably in that order.

1.2>> Graduate program
The Department of Mechanical Engineering fosters a community of scholars, among its faculty members and graduate students, with the interest of advancing knowledge and contributing to the profession. The department offers three graduate programs leading to the following degrees:

> Master of Engineering, major Mechanical Engineering
> Master of Mechanical Engineering in Applied Energy, and
> Doctor of Philosophy, PhD

Master of Engineering, major Mechanical Engineering
The Master of Engineering, major Mechanical Engineering program is designed to provide graduates with an opportunity to advance their understanding of the fundamentals of mechanical engineering in at least one of the following major areas: thermal and fluid sciences; design, materials, and manufacturing; and mechatronics. It is also designed to provide students with a significant research experience.

Master of Mechanical Engineering, major applied Energy
The Master of Mechanical Engineering, major Applied Energy is designed to educate engineers to design and manage efficient energy systems for buildings with high-quality indoor environments; to integrate renewable energy technologies with conventional energy systems to improve sustainability of energy supply systems; to understand the economic, policy, and regulatory frameworks within which decisions on sustainable energy utilization practices are made; and to assess and evaluate the impact of technical developments in energy systems on society, the environment, and the economy.

Doctor of Philosophy
The Doctor of Philosophy graduate curriculum emphasises the acquisition of advanced knowledge and fosters an individual experience of significant intellectual exploration.
2>> Admission Requirements

2.1>> Application Deadlines
Early Applications received by the Office of Admissions, prior to the deadlines stated below [and indicated on the Application Form], are reviewed and decisions are rendered by the department and the Graduate Studies Committee normally within six weeks. Potential students are given one month to decide on accepting admission and assistantships or they will lose the latter.

1> Applications for admission to graduate study should be received by the following dates of every year for early consideration:
   April 1 for summer or fall admission
   November 1 for spring admission
2> Applications received after the deadline of April 1 will be considered on a rolling basis, but not beyond July 31 for fall admission and May 31 for summer admission. Applications for spring admission will not be considered beyond November 1.
3> Applications are considered complete upon receipt of at least two letters of recommendation from professors or supervisors of the applicants, and an official transcript covering at least the end of the first semester of the senior year or its equivalent.
4> All applications may include an application for graduate assistantships if desired. All applications for graduate assistantships received at a later date [rolling-basis] will be considered, pending availability.
5> Admission decisions each year are announced along with grants of graduate assistantships by the following dates:
   May 15 for summer or fall admissions.
   December 15 for spring admissions.

2.2>> Master of engineering program admission
A student applying for admission to a graduate program is only eligible if s/he has a bachelor of engineering degree with a mechanical engineering major or the equivalent. A student must also satisfy the requirements of the University and the Faculty of Engineering and Architecture (FEA) for admission to graduate study.

Process of admission>
1> The Office of Admissions forwards applications for graduate admission to the Dean’s Office on a weekly basis. The Dean’s Office in turn forwards the applications to the departments. The Graduate Faculty Advisor, the departmental representative on the Graduate Studies Committee, and the chairperson consider each case individually.
2> Recommendations for admission and the departmental acceptance letters are forwarded to the Graduate Studies Committee within 10 days of being received from the Dean’s Office.
3> The Faculty Graduate Studies Committee meets in special sessions for admission and recommends to the Dean’s Office cases to be admitted within one week of being received from the departments.
4> The Dean’s Office forwards the admission list and the departmental acceptance letters to the University Admissions Office within two days of their receipt from the Graduate Studies Committee.
5> The Admissions Office will prepare and send the admission packages within ten days of receiving the admission list from the Dean’s Office.
6> Potential students are given one month from the notification date to decide on accepting admissions and assistantships or they lose the latter.
7> Students who are eligible to be admitted on probation may not be notified early but will be notified by the May 15 and December 15 deadlines.
Criteria for graduate admission

Admission to graduate study offered by the departments of the FEA is on a merit basis and is limited to applicants who hold a bachelor’s degree from AUB or from an approved institution in an appropriate field as specified by the department and whose undergraduate or graduate study is, in the opinion of the Graduate Studies Committee and the department in which the applicant proposes to study, of sufficient quality and scope to indicate high promise of success in graduate studies at FEA.

Admission to graduate study will be in one of three categories: admission as a regular student; admission on probation; admission as prospective graduate student. The minimum admission standards in all categories are described below.

Admission as a regular student

An applicant is admitted as a regular student if s/he meets the following minimum admission requirements: An average for the last two years of 80 at AUB or its equivalent at other universities as determined by the Faculty; adequate English proficiency as established by the University; and at least two letters of recommendation from faculty or supervisors familiar with the academic ability of the applicant. An applicant whose last semester grades are not included in the application is admitted provided that s/he maintains an average of 80 for the last two years. The average in all three categories is to be calculated based on all required courses [including elective and humanities courses] taken during the last two years of the student’s undergraduate studies. If the number of credits taken during the last two years is less than 60, previous terms will be considered to meet 60 credits.

Admission on probation

An applicant is admitted on probation if s/he meets the following minimum admission requirements: An average for the last two years of 75 at AUB or its equivalent at other universities as determined by the Faculty; adequate English proficiency as established by the University; and at least two letters of recommendation from faculty familiar with the academic ability of the applicant. A student whose last semester’s grades are not included in the application is admitted on probation provided that s/he maintains an average of 75 for the last two years of undergraduate study. In addition an applicant who does not meet the above minimum requirements but appears to have reasonable potential for success as a graduate student, as manifested by appropriate practical experience or a high score on a relevant standardized exam, such as the GRE, may be admitted on probation. A student admitted on probation must complete nine credits of graduate level coursework during the first two semesters of graduate studies, must pass all courses, and must attain a minimum cumulative average of 80 to become a regular student. If the student fails to meet any of these conditions, s/he will be dropped from the program.

Admission as a prospective graduate student

This category is reserved for students applying to graduate work in a field other than that of their undergraduate major. An applicant is admitted as a prospective graduate student if s/he meets the following minimum admission requirements: An average of 75 at AUB for the last two years of undergraduate study or its equivalent at other universities, as determined by the Faculty; demonstrated good performance in courses related to the field being sought; adequate English proficiency as established by the University; and at least two letters of recommendation from faculty members familiar with the academic ability of the applicant. The Graduate Studies Committee shall act on the admission of prospective graduate students upon the recommendation of the department or program of the intended major. The department or program of the intended major, recommends to the Graduate Studies Committee the supplementary undergraduate courses the applicant must complete before being considered for admission to graduate work. Upon the completion of the supplementary undergraduate courses, with an average of at least 80, the department or the academic unit may recommend to the Graduate Studies Committee the admission of the applicant to the graduate program. The supplementary courses must be completed within four consecutive semesters excluding summers.
2.3>> PhD program admission
Candidates for the doctoral degree program are expected to have an outstanding academic record demonstrated by a minimum undergraduate cumulative grade average of 80.0 according to AUB standards [3.0 GPA in a 4.0 grade system] and have completed a master’s degree in mechanical engineering or a related discipline with a cumulative grade average of 85.0 according to AUB standards [3.33 GPA in a 4.0 grade system].
The application to the doctoral program will follow the deadlines set by the Admissions Office. All applicants are required to take the General Exam part of the Graduate Record Examination [GRE] and submit their scores. Students other than AUB graduates and graduates of recognised colleges or universities in North America, Great Britain, Australia, and New Zealand are required to take the Test of English as a Foreign Language [TOEFL] and receive a minimum score of 600 if taken manually, or 250 if taken via computer. Admission to the PhD program, upon recommendations of the department and the FEA Graduate Studies Committee, requires approval of the AUB Board of Graduate Studies.
Applications received by the University Office of Admissions are first reviewed by the Mechanical Engineering Graduate Committee [MEGC]. This committee consists of the chairperson of the department, the department representative on FEA Graduate Studies Committee and two other mechanical engineering full-time faculty members. Recommendations for admission into the program are then transmitted to the FEA Graduate Studies Committee [GSC]. The FEA GSC consists of faculty members from the engineering and architecture departments, and is chaired by the Dean of the FEA, or his representative. The recommendations of the FEA GSC are then transmitted to the University Board of Graduate Studies [BGS]. This board is a University Senate committee chaired by the provost, and consists of faculty members from the various university Faculties. The Board of Graduate Studies makes the final decision on admission of PhD students.

2.4>> English Language Proficiency Requirement (ELPR)
Applicants to the graduate program, other than AUB graduates and graduates of recognized colleges or universities in North America, Great Britain, Australia, and New Zealand, must meet the English Language Proficiency Requirement (ELPR).
Applicants who are admitted to graduate study, or prospective graduate study, from recognized institutions of higher education with scores on the English proficiency tests as indicated below will be required to take the following English courses:

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<td>paper-based</td>
<td>computer-based</td>
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<tr>
<td>&lt;500</td>
<td>&lt;573</td>
<td>&lt;230</td>
</tr>
<tr>
<td>500-549</td>
<td>573-599</td>
<td>230-249</td>
</tr>
<tr>
<td>&gt;550</td>
<td>&gt;600</td>
<td>&gt;250</td>
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*Note that accepted graduate students who score between 80 and 88 on the IBT or its equivalent on the EEE may be eligible to take UPEN 007: English for Engineering Graduates. For more information, students should contact the department to which they were accepted. Students who successfully complete the UPEN 007 will be required to enrol in the ENGL 30. A student enrolled in ENGL 300 may enrol in only one engineering course.
Information and application forms for the TOEFL can be requested from:

Educational Testing Service AMIDEAST
Rosedale Road, P.O. Box 6155 Riad El Solh, Bazerkan Building
Princeton, NJ 08541-6155 Beirut, LEBANON
USA E-mail: Lebanon@AMIDEAST.org

Applicants who take the TOEFL must use the institutional code number for AUB: 0902, when registering for the test.
3.1 Objectives

1. To provide the students with an opportunity to advance their understanding of the fundamentals of mechanical engineering in at least one of the following major areas: thermal and fluid sciences; design, materials, and manufacturing; and mechatronics.
2. To provide the students with a significant research experience.

3.2 General information

The Department of Mechanical Engineering offers a graduate program leading to the degree of Master Engineering, major: Mechanical Engineering. Students may choose to major in any of the following concentration areas:

- Thermal and Fluid Sciences
- Design, Materials, and Manufacturing
- Mechatronics

A student is encouraged to select a concentration area, which s/he will find most interesting. The master's degree requires a minimum of 21 credit hours of course work and a thesis worth 9 credits. It will usually require between 20 and 24 months to complete the master's degree. The student and graduate adviser, in coordination with the thesis committee, will develop a plan of study tailored to the student's specific interest and background. It is advisable that this plan be developed no later than the first month of the second semester of graduate work.

3.3 Program structure and requirements

The required 21 course credit hours and thesis are distributed as follows:

1. A mandatory three-credit course in applied mathematics. Acceptable courses include, but are not limited to the following:
   - MECH 630 Finite Element Methods in Mechanical Engineering
   - MECH 663 Computational Fluid Dynamics
   - MECH 764 Advanced Topics in Computational Fluid Dynamics
   - ENMG 604 Deterministic Optimization Models
   - MATH 307 Topics in Analysis

   The math course or math-oriented course offered by other departments must be approved by the graduate student adviser.

2. At least two advanced fundamental mechanical engineering three-credit courses from two concentrations, which are not in the same concentration selected by the student, and as approved by the graduate thesis adviser. The following is a list of recommended courses by concentration:
   - Thermal and Fluid Sciences: MECH 701, MECH 760, MECH 761, MECH 762
   - Design, Materials, and Manufacturing: MECH 624, MECH 720, MECH 721

3. Four technical courses [12 credit hours]. Of these, a minimum of three courses must be completed in the major area of concentration to achieve greater depth in that area. It is advisable to make the course selection in connection with thesis work. A maximum of three credit hours may be completed in other engineering graduate programs, subject to approval by the graduate adviser. The following is a list of recommended mechanical engineering technical courses by concentration:
   - Thermal and Fluid Sciences: MECH 602, MECH 603, MECH 604, MECH 606, MECH 607, MECH 609, MECH 663, MECH 665, MECH 701, MECH 702, MECH 703, MECH 707, MECH 760, MECH 761, MECH 762, MECH 764


A student may not register more than once in MECH 796, Special Projects in Mechanical Engineering.

> Seminar Course: MECH 797 [zero credit]. Students must register for the course once per year.

> Thesis: MECH 799 [equivalent to nine credit hours] based on independent research.

A description of all graduate courses can be found in appendix i.
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4.1>> objectives
The objectives of the master’s program leading to the Master of Mechanical Engineering: major, Applied Energy degree are for its graduates to be able to:

1> Design and manage efficient energy systems for buildings with high-quality indoor environment.
2> Integrate renewable energy technologies with conventional energy systems to improve sustainability of energy supply systems.
3> Understand the economic, policy and regulatory frameworks within which decisions on sustainable energy utilization practices are made.
4> Assess and evaluate the impact of new technical developments in energy systems on society, the environment, and economy.

4.2>> program structure and requirements
The master’s degree with the thesis option will normally require between 20 to 24 months for completion. The program consists of 30 credit hours: 21 course credits and 9 thesis credit hours distributed as follows:

1> Nine credits of mandatory courses selected from the following list: MECH 671, MECH 672, MECH 673, MECH 674.

2> Six credits of lab and special courses, including a minimum of one graduate level lab course. Lab and special courses are defined as follows:
   ▪ A graduate lab course corresponds to 2 credits [8 units>12 ects credits].
   Suggested labs include but are not limited to: MECH 670 Laboratory for Renewable Energy in Buildings; MECH 679 Energy Audit Lab; MECH 770 HVAC and Refrigeration Systems Lab.
   ▪ A special course is a block course or a seminar course that corresponds to 1 or 2 credits depending on its duration and content. Special courses could be given by experts from local or international industry, or by visiting faculty members from partner universities.

3> Six credits of elective courses selected with the approval of the graduate student’s advisor in any of the following areas: sustainable energy production from renewable sources, hybrid systems, and sustainable energy utilization practices in the context of buildings. At least one course can be selected from the below pool and one course can be taken from outside the pool as approved by the thesis advisor.
   The pool of approved technical elective courses includes:
   MECH 603, MECH 675, MECH 676, MECH 677, MECH 678, MECH 701, MECH 771, MECH 772, MECH 773, MECH 778.
   The elective courses can be replaced by courses taken during an exchange semester at one of the energy program partner universities. A maximum of six credits can be counted from an exchange semester.

4> Seminar Course: MECH 797 [zero credit]. This is a pass/fail course based on attendance and is offered at least once per year. Students must register for it each time it is offered.

5> Thesis: MECH 788 [equivalent to 9 credit hours]. The thesis must be based on independent research.
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5>> Non-thesis Master of Mechanical Engineering

5.1>> Objectives
To provide the students the opportunity to advance their understanding of the fundamentals of mechanical engineering in at least one of the following major areas:

I. Thermal and fluid sciences;
II. Design, materials, and manufacturing;
III. Mechatronics.

The non-thesis program is primarily intended for individuals planning to enter engineering practice who seek to deepen their knowledge in advanced mechanical engineering subjects. The program is not considered a gateway to a career in academic research or to the PhD program. Students enrolled in the course-based master's degree are not eligible for tuition support from the ME department. However, they are eligible to petition to waive up to 9-credits of graduate courses if these courses satisfy the criteria for waiving graduate courses.

5.2>> program structure and requirements
The course-based Master's program requires a minimum of 33 credit hours of graduate level course, as described below.

1> A minimum of a three-credit course in applied mathematics. Acceptable courses include, but are not limited to the following:

- MECH 630 Finite Element Methods in Mechanical Engineering
- MECH 663 Computational Fluid Dynamics
- MECH 764 Advanced Topics in Computational Fluid Dynamics
- ENMG 604 Deterministic Optimization Models
- MATH 307 Topics in Analysis

The math course or math-oriented course offered by other departments must be approved by the graduate student's adviser.

2> At least three advanced fundamental ("core") mechanical engineering three-credit courses in the different concentration areas: (i) Thermal and Fluid Sciences, (ii) Design, Materials, and Manufacturing, and (iii) Mechatronics. Each of the three courses should be taken in a different concentration area. These concentration areas are listed below.

Thermal and Fluid Sciences: MECH 609, MECH 663, MECH 665, MECH 701, MECH 702, MECH 703, MECH 705, MECH 707, MECH 751, MECH 760, MECH 761, MECH 762, MECH 764, MECH 765, MECH 766, MECH 767, MECH 768, MECH 769, MECH 898.


3> At least 21 credit hours of elective graduate courses in mechanical engineering or closely related areas with approval of the advisor out of which a minimum of 9 credits should be in one concentration.

4> All students registered in the program must take MECH 797 seminar in mechanical engineering whenever it is offered.
5. Qualification examination should be completed at the end of the second semester of the enrollment in the Masters program.

5.3 Master qualification examination
The students in the non-thesis graduate program must take the comprehensive examination after enrolling in all major and minor area courses, and not later than the second week of the term in which the student is expected to graduate.
A supervisory committee conducts the comprehensive examination. The examination is an oral examination that consists of questions related to the student’s graduate courses in addition to background questions related to the major and minor areas.
6>> Master’s Programs Regulations

6.1>> Special topic courses
Special Topics is a three credit-hour graduate level course, which may be given as a conventional course to a number of students on a topic that is not in the mainstream of faculty curricula but may arise due to a special interest on the part of a faculty member or a visiting faculty member. Grades in such a course will be reported in the usual numeric format. The course designation will be: Special Topics followed by an appropriate subtitle in brackets.

6.2>> MECH 796: special project course
1> The graduate course “Special projects” is a three credit-hour project given to one student. The grade in such a course will be reported as Excellent [E], Pass [P], or Fail [F], in accordance with University Regulations on Graduate Study. The course designation will be: MECH 796: Special Projects followed by an appropriate subtitle in brackets.
2> To offer a course as a special project, the instructor giving the course must submit a proposal to the chairperson of the department for approval. The chairperson’s decision should be based on consultations with all the faculty of the department, or with the group of faculty members whose area of specialty is relevant to the subject matter.
3> Every special project course must have a report on the work done and the basis on which the grade was given. This report must be kept in the course file of the department.
4> A graduate student may take only one special project course during his/her graduate program. If the subject matter of MECH 796 is relevant to the thesis topic, the Thesis Committee should take the work done into consideration in its evaluation of the thesis of the student.

6.3>> MECH 797: seminar course
1> The MECH 797: seminar course is a zero-credit graduate level course offered annually by each department/graduate program on a biweekly basis.
2> All graduate students are required to register for the seminar course offered by their department/program in accordance with each program’s policy.
3> At the beginning of the semester in which it is offered, every department/program shall issue a schedule of seminars describing for each session the date, speaker, topic, and chairperson. The speakers could be graduate students or faculty members.
4> Graduate students are expected to present progress reports on their thesis or project research. The time allocated to a presentation should not exceed 30 minutes, the remaining time being left for discussion.
5> Attendance is mandatory. A student registered in the course is not allowed more than one unexcused absence.
6> The grade [P/F] is based solely on attendance. A single 'F' is cleared by a 'P.' A student who accumulates two failures [F] will be dropped from the Faculty.

6.4>> Proposed plan of study form
By the end of the second semester, a graduate student and his/her thesis advisor should complete the Proposed Program of Study form GS-1 with a tentative plan of study including a tentative thesis topic and submit it to the chairperson of the department for approval. The form is included in appendix iii.

6.5>> Procedure for master’s thesis proposal and defense
1> During the course of the graduate program followed by a graduate student, the student is expected to meet with faculty members in the mechanical department to
discuss possible thesis topics and arrange to have a thesis advisor. Normally, the thesis advisor is from among the full-time professorial faculty of the department.

2> When ready to start work on the thesis, the student must present, to the chairperson of the mechanical department, a written thesis proposal, approved by the thesis advisor, stating the project objectives, scope of work with relevant literature, research methodology, expected results, and indicate the expected date of graduation.

3> The chairperson, upon approval of the thesis proposal, will select the members of the Thesis Committee in consultation with the thesis advisor. If the thesis advisor is from another department, then the chairperson of the mechanical engineering will consult with the chairperson of the department to which the thesis advisor belongs. The Thesis Committee shall be composed of the thesis advisor as chairperson and at least two other members. At least two members of the committee must be members of the mechanical department. The remaining member[s] may be from the department, the Faculty, the University or from an institution other than AUB.

4> The student must discuss his/her thesis proposal with members of the Thesis Committee and receive their approval. The student’s proposal must be signed by all members of the Thesis Committee prior to its submittal, by the mechanical department chairperson, to the Graduate Studies Committee.

5> The chairperson of the mechanical department will submit the thesis proposal with the names of the Thesis Committee members to the Graduate Studies Committee for approval.

6> The Graduate Studies Committee will then inform the chairperson of the thesis proposal approval, and the chairperson will communicate the approval to the Thesis Advisor. The deadlines for approval by the Graduate Studies Committee for students who wish to graduate in October, February, or July are: June 20, October 20, and February 1, respectively.

7> It is the student’s responsibility to keep members of the Thesis Committee informed on the progress of his/her work and to seek their input.

8> All requirements for the master’s degree must be completed within a period of four years after admission to graduate study. Extension requires justification and approval by the Graduate Studies Committee.

9> A student must be registered for the thesis (MECH 788 in ME-AE or MECH 799 in ME-ME) in the term in which s/he is expected to graduate.

10> The thesis defense should take place at least four months after the approval of the Graduate Studies Committee. The deadlines for the thesis defense for students who wish to graduate in October, February, or July are: June 10, Oct. 30, and March 1, respectively.

11> A graduate student may not have his/her thesis defense until s/he has successfully completed the course requirements for the master’s degree. The thesis may be defended after the results of the final examinations become available and before the start of the following term.

12> A final draft of the thesis should not be prepared before it is discussed with each member of the Thesis Committee. The final draft of the thesis must be submitted to each member of the Thesis Committee at least one week before the date of the thesis defense.

13> The thesis defense is open to the public and must be announced at least two weeks in advance. The total time allocated for the thesis defense should allow for answering all questions and should normally not exceed 90 minutes.

14> The thesis defense session is normally chaired by the thesis advisor and shall be conducted according to the following procedure:

Introduction of the student defending the thesis by the thesis advisor.
Presentation of the work by the student in 35 to 40 minutes.
Questions, first from members of the Thesis Committee then the public, starting with general and clarification questions, followed by more specific, technical questions.
At the end of the thesis defense, the student and the public will be requested to leave the room to allow the Thesis Committee to deliberate and reach a decision concerning the evaluation of the thesis.

The student will be notified of the final decision by Thesis Committee immediately following completion of the deliberations.

15> The results of the Thesis [or Project] defense must be reported on a special form [available in the Dean’s Office], signed by the chairperson and members of the Thesis Committee. This form must be sent by the chairperson of the mechanical department to the Registrar with a list of the graduate courses completed by the student, and the grades obtained in these courses.

16> The chairperson of the mechanical department must write to the Dean recommending that the student be granted the master's degree.

17> The student, after passing the thesis defense, must deposit three copies of the thesis, complete with abstract and signatures of the members of the Thesis Committee, to the Jafet Memorial Library. The receipt of these copies must be submitted by the student to the Office of the Registrar. The student must sign a release form indicating whether or not s/he authorises the library to supply copies of the thesis to other libraries or individuals.

6.6>> Academic evaluation

1> A student admitted on probation must complete nine credits of graduate level courses during the first two semesters of graduate studies, pass all courses, and attain a minimum cumulative average of 80 to become a “regular” student. If the student fails to meet any of these conditions, s/he will be dropped from the program.

2> A student is placed on probation if s/he attains a cumulative average between 70 but less than 80. This probation must be removed at the end of the following term by attainment of a cumulative average of at least 80. If the student fails to remove the probation status, the student will be dropped from the graduate program.

3> A student is dropped from the graduate program if s/he attains a cumulative average of 70 or more, but less than 80, in any term and fails one course in that term.

[This rule does not apply to the first term of study.]

4> A student is dropped from the graduate program if s/he attains a cumulative average of less than 70 or fails two courses in one term.

5> A student who accumulates two consecutive failures in the Seminar Course will be dropped from the Faculty.

6> A student dropped from a graduate program will not be allowed to re-enroll in the same program at any future date.

6.7>> Regulations for graduate students taking undergraduate courses

1> Graduate students required to take undergraduate courses must obtain a grade of at least 70 in each undergraduate course taken.

2> If a student fails to obtain a grade of 70 in any of these undergraduate courses, the student is allowed to repeat that course only once.

3> Failure to meet the above stipulations will result in the student being dropped from the graduate program.

6.8>> Residence requirements

To meet the minimum residence requirements for the master's degree, a student must register and be in residence as a graduate student for at least two semesters, one semester and two summers, or four summers.

All requirements for the master's degree must be completed within a period of four years after admission to graduate study. Students attending only summer sessions must complete all requirements within a period of six summers after admission to graduate study. Extension beyond the maximum allowed period of study requires the approval of the graduate committee of the Faculty.
6.90** Graduation requirements**
To be eligible for graduation with a master's degree from the Faculty of Engineering and Architecture, a graduate student must have:
1> Satisfied promotion requirements throughout the program.
2> Completed a minimum of 24 credit hours of course work.
3> Completed thesis requirements.
4> Met the residence requirements specified for the master's degree on page 23.

6.10** Graduate level courses**
The minimum passing grade for a graduate course is 70. Students in graduate study programs are required to maintain a cumulative average of at least 80 in all courses taken for graduate credit. A student who is absent without excuse from more than one third of the number of sessions in any one course, or who fails to sit for scheduled examinations, or fails to fulfill required written or oral work, will be given the minimum grade for graduate courses, which is 55. Results of tutorial courses, projects, or theses will be reported as Pass [P] or Fail [F].

6.11** Pre-requisite courses**
Undergraduate courses are normally taken to make up for deficiencies in the student's background. They do not carry graduate credit. The minimum passing grade for a prerequisite course is 70; however, a department or program may set a higher minimum passing grade.
7>> doctor of philosophy, major: mechanical engineering

7.1>> General information
The graduate curriculum offers students opportunities to develop levels of expertise and knowledge consistent with a career of technical leadership. The doctoral program emphasizes the acquisition of advanced knowledge and the fostering of an individual experience of significant intellectual exploration.

7.2>> Admission requirements
Candidates for the doctoral degree program are expected to have an outstanding academic record demonstrated by a minimum undergraduate cumulative grade average of 80.0 according to AUB standards (3.0 GPA in a 4.0 grade system), and have completed a master's degree in mechanical engineering or a related discipline with a cumulative grade average of 85.0 according to AUB standards (3.33 GPA in a 4.0 grade system).

The application to the doctoral program follows the deadlines set by the Admissions Office. All applicants are required to take the General Exam section of the Graduate Record Examination (GRE) and submit their scores. Students other than AUB graduates and graduates of recognized colleges or universities in North America, Great Britain, Australia, and New Zealand are required to take the Test of English as a Foreign Language (TOEFL) and receive a minimum score of 600 if taken manually, or 250 if taken via computer. Admission to the PhD Program is upon the recommendations of the department and the FEA Graduate Studies Committee, and requires the approval of the AUB Board of Graduate Studies.

7.3>> Course requirements
The PhD program requires a minimum of 18 credit hours of course work beyond the master’s degree.

Major course area requirements
At least nine credit hours of core courses of advanced study in mechanical engineering are needed to satisfy this requirement. The courses should be in the major research area of the student and must be approved by the student's graduate dissertation advisor. This will enable the doctoral candidate to pursue course work in direct support of his/her research. The course work must address all recommendations, made during the qualification period, by the student's adviser and dissertation committee.

The following major course areas are offered:
- Thermal and Fluid Sciences
- Mechatronics
- Design, Materials, and Manufacturing

Mathematics course requirements
A three credit advanced course in mathematics is required from all doctoral candidates. The course must be approved by the adviser of the candidate. The mathematics course requirement is satisfied if the student has completed at least six credits of advanced courses in math beyond the bachelor’s degree.

Minor subject requirements
The minor is a program of advanced study that will help the student to develop knowledge and some competence in an area other than the candidate's major field of study that is related to his/her research area. Two graduate courses [not less than six credits] must be taken in a coherent field that is different from the major field of study. These six credit hours must be taken outside of the Mechanical Engineering Department [i.e. in other engineering or basic science departments]; some of this requirement could be satisfied through coursework done during the student's master's degree program. This, however, will not reduce the required minimum of 18 credit hours of course work needed beyond the master’s
degree. All courses taken in this minor area must be at the graduate level and must be taken while the student is registered in a graduate program at the AUB. The minor subject must be approved in advance by the student's dissertation committee, and by the FEA Graduate Studies Committee. The approval of the department offering the minor should also be sought.

If the student chooses mathematics as his/her minor then the course taken to fulfill the mathematics course requirement will count towards the minor subject requirements.

7.4 Advisors
After admission into the department, a general advisor will be assigned to the PhD student to guide her/him with the initial selection of courses and to introduce the student to the various research areas in the department. The student must select a thesis advisor by the end of the first semester after admission to the program. The student must seek the faculty members that are in the student's area of interest, and discuss with them possible research topics for their PhD thesis. Once a thesis advisor is identified, the student will develop a Proposed Program of Study that lists the courses the student intends to take and the proposed dates for the written and oral Doctoral Qualifying Examinations. The Proposed Program of Study must then be submitted to the ME Graduate Committee for approval.

7.5 PhD qualification examination
The qualification examination for admission to PhD candidacy has two parts. Part 1: the written qualification examination must be completed before the end of the second semester of enrolment in the doctoral program. Part 2: the oral qualification examination must be completed within one year following the completion of Part 1.

The purpose of the qualifying examination is to determine whether the applicant possesses the attributes of a doctoral candidate: mastery of the core mechanical engineering disciplines, ingenuity and skill in solving unfamiliar problems.

The oral and written qualifying examinations will be held at end of the fall and the spring semester every year.

The mechanical engineering faculty will review each student's performance in the qualifying examination and decide whether s/he passes or fails. Students who fail sections of Part 1 may be permitted to take that section of the examination again, in which case they must do so the next time it is offered. In no case will a student be allowed to repeat any section of this examination more than once.

Part 1: written qualification examination>
In the written qualification examination, students sit for exams in four sub-disciplines which are normally selected from the list of the following topics:

1> Applied Mechanics
2> Materials and Manufacturing Processes
3> System Dynamics and Control
4> Mechanical Design
5> Fluid Dynamics
6> Thermodynamics
7> Heat and Mass Transfer

Part 2: oral qualification examination>
Students must give a presentation on their proposed dissertation research area to a committee comprised of the dissertation adviser(s), the dissertation committee members, and other interested faculty. The proposed oral examination will include questioning by the committee to assess whether the candidate has sufficient background to perform research in their chosen area. The oral examination may include a component in the student's major core area of studies. The criterion for passing requires that the research topic is of PhD standard, original, clear in its contribution to existing knowledge, and that the proposed methodology is appropriate. A student who fails the oral qualification examination should
repeat it within four months after addressing the comments of the dissertation committee compiled by the dissertation committee chair in the examination report.

**Thesis proposal**
Following successful completion of the first part of the qualifying examination, all PhD candidates must submit a thesis proposal summarizing their thesis problem and the planned approach. The purpose of the proposal is to inform the department and faculty, in a concise statement, of the candidate’s research program. It should explain what the student intends to do and how s/he intends to go about it. The thesis proposal must provide sufficient literature citation to indicate an awareness of previous work, and enough detail to show how the work is expected to advance knowledge in the field.

**Doctoral thesis committee**
The dissertation committee should be composed of at least five members, one of whom should be from outside the department/program and one from outside the university. The adviser and at least three of the committee members must be of professorial rank. All members of the committee must hold a doctoral degree in a relevant field. The chair of the committee must be a full professor who is not the PhD thesis adviser (Requirement of the Lebanese Ministry of Higher Education).
Members of the doctoral dissertation committee are recommended by the student’s adviser and approved by the department, and the Faculty Graduate Studies Committee, and the Board of Graduate Studies.
The doctoral dissertation committee approves the thesis topic, research plan, conducts the thesis proposal defense (Part II of the Qualifying Exam) and conducts the thesis defense. The thesis proposal and the selection of the thesis committee should be approved at least two semesters before the student defends his/her thesis. The PhD thesis topic, examining committee, and admission to candidacy require Board of Graduate Studies approval.

**External Examiner**
An external examiner of high standing from abroad will be nominated by the chair of the department in consultation with the dissertation adviser, to review the dissertation before the defense. Comments by the external examiner will be shared with the student. The student will then be given an opportunity to revise the dissertation and incorporate revisions in the work in a timely manner. The external examiner may choose to attend the dissertation defense and participate in the deliberations.
All PhD candidates must defend their dissertation in an oral examination, open to the community, in which a candidate is examined by his/her committee.

**7.6 Course plan for phd students**
All courses that are offered for credit in the master's program will also be offered as graduate courses for those in the PhD program.

**Math requirement courses**
At least one math course offered outside the ME department and approved by the graduate student’s adviser. Acceptable courses include:
MATH 307 Topics in Analysis
CMPS 354 Finite Element Method
CMPS 350 Discrete Models for Differential Equations
CMPS 373 Parallel Computing

Note that in the Faculty of Arts and Sciences, 300 level courses are graduate courses.

Major area courses:
*Thermal and fluid sciences*
MECH 606, MECH 607, MECH 608, MECH 660, MECH 663, MECH 665, MECH 701, MECH 702, MECH 703, MECH 707, MECH 751, MECH 760, MECH 761, MECH 762, MECH 764, MECH 765,
6>> doctor of philosophy

MECH 766, MECH 767, MECH 768, MECH 769, MECH 771, MECH 772, MECH 773, MECH 778 and MECH 898.

Mechatronics>

Design, materials and manufacturing>

Seminar course>
Seminar Course: MECH 797 [no credit]. The student must register for the course once a year. This is a pass fail course.

7.7>> PhD dissertation [MECH 899]
The dissertation is based on independent original research. A student is required to register for a minimum of 30 credits of dissertation work. A student may register for a maximum of twelve credits in any given semester. Dissertation credit may be repeated as many times as necessary. The student must submit a dissertation based on results of original, independent research. The PhD dissertation is expected to make a significant contribution in mechanical engineering. Upon completion of the dissertation and after its approval by the student's dissertation adviser, a final oral examination will constitute the examination defense.

7.8>> Residence requirements
The student must register for at least four semesters beyond the completion of the master's degree. Requirements of the degree of Doctor of Philosophy must be completed within a period of five years after starting graduate work beyond the master's degree. An extension will require the approval of the AUB Board of Graduate Studies.

7.9>> Graduation requirements
A student can graduate at the end of any academic semester in which s/he has satisfied the following requirements:
1> Met the residence requirements and all pertinent AUB regulations.
2> Has at least one paper, based on his/her PhD dissertation, accepted in a peer reviewed technical journal, in addition to one refereed conference paper
3> Passed all the required courses and completed the research credit requirements.
4> Attained a minimum cumulative course average of 85 beyond the master's degree and not be on probation.
5> Passed the Doctoral Qualifying Examinations.
6> Successfully defended a dissertation of original scholarly work.
7> Deemed worthy by the Faculty.
8>> graduate assistantship [GA] and graduate research assistantship [GRA]

8.1>> Appointment
Fellowships covering tuition and stipends are available for students at the graduate level in return for assisting faculty members in teaching and/or research for a specified number of hours per week in an academic department. Recipients are selected on the basis of academic record and departmental need. Applications may be obtained from the Office of the Dean of the Faculty to which the student is applying and should be filled out prior to the beginning of the semester, meeting a deadline set by the Faculty. The following rules apply to Graduate Assistants [GAs] and Graduate Research Assistants [GRAs]:

1. GA appointments should normally be given only to graduate students, new or continuing, with a clear status [not on probation]. Exceptions should be approved by the dean beforehand.
2. GA appointments of a student working for a master’s degree are limited to a total of four regular semesters and one summer term.
3. GA appointments should be finalized as much as possible before the beginning of the semester and no later than seven days after the start of the semester [three days in the summer term].
4. A GA appointment is related to the number of tuition exempt credits the GA receives in a given semester. A GA with a 1/3 appointment will receive a tuition waiver for three credits and will provide 7 hours of teaching assistance per week. A GA with a 2/3 appointment will receive a tuition waiver for six credits and will provide 14 hours of teaching assistance per week. A GA with a 1/2 appointment will receive a tuition waiver for four and a half credits and will provide 10 hours of teaching assistance per week. A GA with a full appointment will receive a tuition waiver for nine credits and will provide 20 hours of teaching assistance per week. [During the summer term, a 1/3 GA requires 10 hours of teaching assistance per week; a 2/3 appointment requires 20 hours per week].
5. The primary job of a GA is in assisting in teaching and educational related activities.
6. GAs should have written educational tasks defined at the beginning of each semester to satisfy the workload based on the percentage of the appointment.
7. A GA will be assigned to an instructor after consultation with the instructor. The instructor will take part in assigning the teaching and education related duties to the GA. The instructor should provide the department and the dean’s office at the end of each semester or term with an evaluation of each GA assigned to him or her.
8. GRA appointments are encouraged. A GRA is partially supported by a GA appointment that carries with it a teaching assistance workload, and partially by research grants to assist a faculty member [or members] in research activities. For example, a GRA with 1/4 GA appointment and 1/4 RA appointment is expected to provide 5 hours of teaching and education related assistance per week. The student will also receive tuition waiver for a 3-credit course. If a student is taking 6 credits, the tuition of the other 3 credits will be charged to the faculty member’s research funds.
9. A GRA with 0% GA appointment does not have to assist in teaching and devotes all of his or her time to assisting a faculty member in research.
10. GA or GRA appointments can be made across departments. For example, a GA or a GRA in Engineering Management may be assigned teaching and educational duties in CEE, ME, or ECE and vice versa.

8.2>> Faculty mentorship
The following rules are adapted from the University of Illinois at UC:

1. Faculty will foster the development of excellence in every graduate student.
In relations with students, the graduate faculty will be candid, fair, and committed to the student’s welfare and progress. Faculty will conscientiously supervise, encourage, and support students in their academic endeavours and assist them in securing research support and seeking professional employment. Faculty will not discriminate among graduate students on the basis of gender, sexual orientation, marital status, age, ethnic background, disability, religion, national origin, or any other factor unrelated to competence or performance. Faculty will advise students concerning the ethics of the profession, encourage the practice of research and publication consistent with ethical standards, and help students avoid ethically questionable projects. Faculty will advise students about career opportunities and implications associated with their participation in particular research projects or degree programs. Faculty will strive to enhance the educational value of teaching and research assistantships of the students under their supervision. Faculty will be objective in the evaluation of research and academic performance and will communicate that evaluation fully and honestly to their students. Faculty will report accurately on the competence of students to other professionals who require such evaluations. Faculty will not permit personal animosities or intellectual differences with colleagues to impede student access to those colleagues or interfere with students’ research or progress towards a degree. When engaged in teaching, research, or supervision, faculty will recognize the power they hold and will avoid engaging in conduct that exploits or demeans students or that could be perceived as an abuse of that power. Faculty are responsible for all phases of graduate education and will be accessible to students who are under their guidance.

8.3 graduate teaching assistants

Graduate students with superior records in their undergraduate and/or graduate work are recommended by the ME department to the FEA Dean for appointment as Graduate Teaching Assistants [GAs] on an academic term basis. Renewal of GA appointments depends on the student’s performance evaluation and progress towards their graduate degree. GAs are required to provide duties related to instructional program of the ME department [e.g., teaching laboratories or discussion sections, grading papers]. The work schedule and the duties to be performed by the graduate assistant will be determined by the department at the time of appointment. The thesis adviser of the student may advise the department on the suitability of the duties for a given student, however the over-riding factor in the assignment remains the undergraduate instructional mission of the mission of the department. The graduate assistant should be regarded as a student providing service as part of learning experience rather than an employee whose education is secondary. A student working for a master’s degree may be appointed as a GA for a maximum of four regular semesters and one summer term. The GA appointment normally includes tuition support for 6 credits in addition to a monthly stipend. Normally, graduate students who hold a part-time job outside AUB are not entitled to more than 1/3 GA support. Normally, graduate students who have full-time jobs outside the university are not eligible for GA appointments. Graduate assistants must inform the department about changes in their outside work status.
Graduate research assistants

1. A graduate student may be appointed as a Graduate Research Assistant (GRA) by a faculty member. The GRA is normally connected to a funded research program, and includes tuition and/or monthly stipend support to be negotiated with the concerned faculty member.
2. The work schedule and the duties to be performed by the GRA appointment are determined by the faculty member concerned.
3. A GRA appointment is normally given on a semester basis.
4. Renewal of GRA appointments is subject to satisfactory performance of the GRA and the continued availability of funds.
9>> Laboratory Access

9.1>> Personnel assignment to laboratories
All space assignments for graduate students and research staff are coordinated by the ME department chairperson to check space availability and to ensure that the priority system [described below] is followed. Faculty members may not promise space to a student or Research Associate without the written authorization of the ME department chairperson. The department chair’s written authorization shall specify: the particular laboratory, the duration of the authorization, and any special terms or conditions of use. The lab manager will keep on file the currently authorised lab users and be responsible for enforcing the policy.

The department provides limited office or laboratory space to graduate students and research staff normally in the lab in which they are conducting their research in the following priority:

1> Post-doctoral staff, research associates, full-time research assistants.
2> Full-time graduate students who have a 100% appointment (GA, GRA, or some combination). The greater the number of semesters in the program, the higher the priority.
3> Graduate students who have 50% appointment as GRA.
4> Full-time graduate students who have GA appointments. The greater the percentage of the appointment, the higher the priority.
5> New graduate students who do not have a GA or GRA appointment have the lowest priority in space assignment.

9.2>> Assignment of computers
1> Normally, students assigned a space in the ME Labs will also be given use of a desktop computer. No more than two students may be assigned to a single computer.
2> Computers purchased with funds from a specific grant are normally assigned to students working on the grant project, by the faculty member in charge of the grant. These computers may not be used for other purposes during the life of the grant.
3> Only students with assigned office space are eligible for a computer assignment. Students without office space may use the IT Unit shared computing resources.
4> Graduate students who have their own laptops should be given IP addresses by the system administrator to access the internet and the AUB database.

9.3>> Use of laboratories
The ME laboratories are classified as instructional labs, research labs, or both. Instructional labs are dedicated to supporting undergraduate courses and have as custodian, the ME lab manager in coordination with the faculty members using the labs during a certain semester. Research laboratories are generally used for research and to support graduate courses. One or more faculty member working in a specific area are usually designated as custodians for a research lab.

The laboratories subject to this policy are listed in the following table, which also designates the type of the lab and the current custodian(s).

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Type</th>
<th>Place</th>
<th>Custodian(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Characterization lab</td>
<td>Research/Instruction</td>
<td>SRB 410-412</td>
<td>Ramsey Hamade</td>
</tr>
<tr>
<td>Fluid Dynamics Lab</td>
<td>Research</td>
<td>SRB 413</td>
<td>Ghanem Oweis</td>
</tr>
<tr>
<td>Thermal-Fluid Lab</td>
<td>Instruction</td>
<td>SRB 419</td>
<td>Nesreen Ghaddar/Alan Shihadeh</td>
</tr>
</tbody>
</table>
The use of ME laboratories is limited to individuals in one or more of the following categories:

a> Faculty members and instructors of the ME department including graduate and undergraduate teaching assistants who are using laboratories to carry out their teaching, research, or service obligations.

b> Permanent and part-time employees, including work study students and part-time student workers, who perform duties in the laboratories related to the ME department mission.

c> ME students using laboratories to carry out work which is assigned as part of a course in which they are currently enrolled.

d> Undergraduate or graduate students who have received written authorization from the department chair to carry out university-related work.

e> Any other person who has received the authorization of the department chairperson to use a particular laboratory.

### 9.4 Other rules for use of the lab office space and computers

1> All students who are not assigned office space are not allowed to use dedicated ME lab computers but can use the IT unit computers which is open for 24 hours.

2> All software available in SRB will also be made available in the IT Unit, and new software required by graduate students and approved by the professor with whom the student is working should be installed at a specified computer[s].

3> Faculty who wish to assign an office area to a student shall coordinate the assignment with the chair to insure space availability and assignment priorities are followed. Students cannot be promised office space before clearing the assignment with the department chair.

4> Graduate students who have their own laptops should be given IP addresses by the system administrator to access the internet and the AUB database.
Awards and Fellowships

10.1 ABDUL HADI DEBS graduate endowment award for academic excellence
Abdul Hadi Debs Award is an annual award for a graduating student with an outstanding academic record, and who has demonstrated research capabilities through a paper, project or thesis deemed by faculty worthy of publication.

10.2 SAKKAL renewable energy graduate thesis award
Emeritus Professor Fateh Sakkal established an annual Renewable Energy Graduate Research/Thesis Award to promote research in the field of renewable energy [RE] and energy efficiency with special applications to Lebanon. The RE Award grant is valued at $3,000 per year offered as a cash prize to a mechanical engineering graduate student at AUB pursuing or having completed a master's thesis in the field of renewable energy and energy efficiency. The RE Award can not be shared by more than two students.

Eligibility criteria>
> The student is a mechanical engineering graduate of AUB.
> Academic merit is the primary criterion for eligible applicants. The applicant should normally have an average of 85 and above in graduate studies. The applicant should demonstrate evidence of quality research work in the field of renewable energy with special applications to Lebanon through a paper or thesis deemed by the ME faculty worth of publication.

Procedure for granting the award>
> Nominations for the award should be received by the department chairperson from mechanical engineering faculty or thesis advisors by April 15 each year. 
> The nomination must include: a C.V. or resume of the nominee, a research statement describing the project and its impact with copies of papers published or submitted for publication to journals or conferences, and/or a copy of the graduate thesis.
> The chairperson appoints a committee from faculty members in the area of energy to study the nominations. The committee presents its recommendation to the department chair.
> The chair forwards the committee recommendation with his/her endorsement to the department for approval.
> The department submits the recommendation to the Dean of Engineering and Architecture.
> The award is announced by the Dean during the reception preceding or following Commencement Exercises.
> The recipient of the award receives a certificate and the cash award. If two recipients are awarded, then the cash award will be equally shared between them.

10.3 PETROFAC graduate fellowship
The Petrofac Graduate Fellowship Program offers two fellowship awards per year to outstanding students pursuing a graduate study program in mechanical engineering at AUB at the master's level. The fellowship award is valued at $12,500/ year/student for up to two years. The award can be used to cover the tuition and stipend. The recipient of the award can get additional support from other sources [research grants of faculty] as long as the total support to the student from all sources covers 100% of tuition and a stipend that does not exceed a payment of $1000/month.

Eligibility criteria>
> The field of study is in mechanical engineering.
> The applicant must be a registered and/or admitted full-time, regular [not "on-leave" or "part-time"] student and must normally have an average of 85 and above in
the last two years of undergraduate or graduate studies [≥ 3.50 grade point average].
In exceptional cases, other evidence of outstanding ability may outweigh this
criterion. Academic merit is the primary criterion for ranking eligible applicants;
departments will advise all applicants in advance if additional criteria will be used.
Academic merit is based on grades, research ability, and progress in the graduate
program. To retain the scholarship, the student must maintain an average of 85 and
show high quality progress on the research work. All publications resulting from the
student work should acknowledge the fellowship program.

> Petrofac Graduate Fellowships are intended to provide students with a period of
time that they can devote largely to graduate studies and research.

**Required application information**

> Application is made on the Application for a Petrofac Graduate Fellowship form. The
completed form and all post-secondary transcripts must be received by the
department by November 30 or April 15.
Applications must include:
> A C.V. or resume.
> Three [3] letters of recommendation are required and must be submitted separately
to the Dean’s Office. You may provide email addresses of applicant references on the
Fellowship Application the Dean’s office will solicit reference letters separately.
> Standardized Test Scores of GRE
> Indication of any external support granted to the applicant.
> Incomplete applications cannot be considered and notification of incompleteness
will not be made. Please make sure applications are complete.

**Selection criteria**

Each of the following criteria is weighted equally:

* Undergraduate Academics
  - Summary of academic program and attachment of transcript[s]
  - Involvement in honors and/or enrichment programs
  - Academic recognition and awards
* Graduate Study Prospects
  - Standardized test scores
  - Graduate study plans
* Personal Statement
  1. Clarification of educational and career goals
  2. Personal factors that have influenced educational achievement
* Letters of Recommendation.
Letters should provide information about the applicant’s:
  - Scholarship with particular reference to capacity for original work as graduate student
  - Character and personality attributes
  - Other observations that can assist in appraising the applicant's probable success in
    advanced study and future career contributions.
Letters should be limited to approximately 350 words; therefore, they should not
focus on:
  - Exceptional quality of the teaching of those writing letters of recommendation
  - Difficulty of the courses taught by those writing letters of recommendation.

The applications will be studied by the Department of Mechanical Engineering. The
nominations of the department will be sent to the dean by the department chair for final
approval.
11.1 faculty and staff

11.1 full time faculty

> Fadhil Mukalled, Professor and Acting Dean, Fellow of the Center of Advanced Mathematical Studies [CAMs], PhD from Louisiana State University. His field of interest is computational fluid dynamics. He joined the department in 1987. [memouk@aub.edu.lb]

> Nesreen Ghaddar, Qatar Chair in Energy Studies Professor, and Associate Provost, PhD from MIT. Her field of interest is computational fluid dynamics, heat transfer and energy conversion. She joined the department in 1991. [farah@aub.edu.lb]

> Marwan Darwish, Professor and Chairperson, PhD from Brunell University. His field of interest is engineering materials and computation method applied to engineering problems. He joined the department in 1992. [darwish@aub.edu.lb]

> Albert Kuran, Associate Professor, MS from Yale. He joined the department in 1956. [akuran@aub.edu.lb]

> Ramsey Hamade, Associate Professor, PhD from Virginia Polytechnic Institute. His field of interest is design, materials, and manufacturing. He joined the department in 2000. [rh13@aub.edu.lb]

> Alan Shihadeh, Associate Professor, ScD from MIT. His field of interest is power engineering and combustion. He joined the department in 2000. [as20@aub.edu.lb]

> Kamel Ghali, Associate Professor, PhD from Kansas State University. His fields of interest are heat and mass transfer, applied energy and thermal comfort. He joined the department in September 2009. [ka04@aub.edu.lb]

> Issam Lakkis, Assistant Professor, PhD from MIT. His fields of interest are computational physics and micro-electromechanical systems. He joined the department in September, 2004. [jl01@aub.edu.lb]

> Ghanem Oweis, Associate Professor, PhD from University of Michigan, Ann Arbor. His field is experimental fluid dynamics. He joined the department in February 2005. [goweis@aub.edu.lb]

> Daniel Asmar, Associate Professor, PhD from University of Waterloo. His areas of interest are robotics, computer vision, and mechatronics. He joined the department in September 2007. [da20@aub.edu.lb]

> Mutasem Shehadeh, Assistant Professor, PhD from Washington State University. His field of interest is computational mechanics. He joined the department in September 2008. [mutasem.shehadeh@aub.edu.lb]

> Matthias Liermann, Assistant Professor, PhD from RWTH Aachen University, Germany. His fields of interest are automatic control, mechanical design, and hydraulics. He joined the department in September 2009. [matthias.liermann@aub.edu.lb]

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Appendix i >> Mechanical Engineering course description

a1.1>> Graduate courses

MECH 600 Applied Reservoir Engineering [3 cr.]
This course introduces the concepts and principles needed to understand and to analyze hydrocarbon reservoir fluid systems; defines (with the help of geological and petro-physical principles) the size and contents of petroleum accumulations. Students will learn to organize programs for systematically collecting, recording, and analyzing data describing fundamental characteristics of individual well and reservoir performance (h.k. pressure, production, PVT data). The course covers topics on: fundamental concepts of fluid distribution, porosity distribution, trapping conditions; nature and type of primary drive mechanisms; production rates, ultimate recoveries, and reserves of reservoirs; supplementary recovery schemes to augment and improve primary recovery; economics analysis of developing and producing reservoirs and conducting supplementary recovery operations. Prerequisite: MECH 314 or CIVE 340.

MECH 602 Energy Conservation and Utilization [3 cr.]
A course that deals with methods for reduction of losses and gains from a building envelope, energy conservation in cooling, heating, air-handling, and plumbing systems, energy management program. Prerequisite: MECH 310, MECH 412.

MECH 603 Solar Energy [3 cr.]
A course discussing the fundamentals of solar radiation, collectors and concentrators, energy storage, estimation and conversion formulas for solar radiation. Prerequisite: MECH 412.

MECH 604 Refrigeration [3 cr.]
A course on fundamental concepts and principles, cold storage; functions and specifications of refrigeration equipment, applications. Prerequisite: MECH 412.

MECH 606 Aerosol Dynamics [3 cr.]
This course covers the physical and chemical principles that underlie the behavior of aerosols—collections of solid or liquid particles suspended in gases, such as clouds, smoke, and dust—and the instruments used to measure them. Topics include: aerosol particle characterization, transport properties and phenomena in quiescent, laminar, and turbulent flows, gas- and particle-particle interactions, and applications to human respiratory tract deposition and atmospheric pollution. Prerequisite: MECH 314, MECH 412, MECH 414, or consent of instructor.

MECH 607 Micro Flows Fundamentals and Applications [3 cr.]
A course on theory and applications of micro flows, the continuum hypothesis and the various flow regimes, shear and pressure driven micro flows, electrokinetically driven liquid micro flows, compressibility effects of micro flow of gases, particulate flows in bio-applications, modeling techniques, hybrid continuum-molecular methods, reduced order modeling of micro flows in multi-physics micro flow applications, case studies in BioMEMS. Prerequisite: MECH 310, MECH 314, and MECH 412, or equivalent.

MECH 608 Applied Reservoir Engineering II [3 cr.]
This course introduces the advance concepts and principles needed to analyze hydrocarbon reservoir fluid systems, and defines the size and contents of petroleum accumulation. Students will learn to organize programs for collecting, recording, and analyze data describing the advanced characteristics of individual well and reservoir performance. This course of advanced reservoir engineering topics covers the concepts of fluid flow in porous medium, fluid distribution, fluid displacement, fractional flow equation and Buckley-Leverete equation, pressure draw-down and pressure buildup analysis, nature and type of primary,
secondary and tertiary recovery, water influx and prediction of water-flood behavior, and reservoir model simulation and history matching. Prerequisite: MECH 600, MECH 314 or CIVE 340

MECH 609 Experimental Methods in Fluid Dynamics [3 cr.]
This course is aimed at introducing students to experimental methods used to measure fluid flow quantities such as pressures, forces, and velocities. The course will start with an introduction to what and why we measure, and to uncertainty analysis and measurement error estimation. Some basic techniques for data reduction and data post-processing will be introduced. The available fluid measurement methods will be surveyed briefly, with selected applications. Emphasis will be on advance optical diagnostic techniques, namely particle image velocimetry [PIV], and laser induced fluorescence [LIF]. The theoretical foundations of these techniques will be established, and the discussion will extend to practical considerations including software and hardware components. A few laboratory sessions will be incorporated into the course to supplement the lectures, and will make use of the instruments available in the ME department including the open circuit wind tunnel, and the PIV system. In addition to the lectures and lab sessions, emphasis will be also on the available literature. Prior knowledge of the basic principles of fluid mechanics and fluid systems is required. MATLAB will be needed for course work. Prerequisite: MECH 314.

MECH 619 Quality Control in Manufacturing Systems [3 cr.]
The course covers the foundations of modern methods of quality control and improvement that may be applied to manufacturing industries. It aims to introduce students to the tools and techniques of quality control used in industrial applications, and develop their ability to apply the tools and techniques to develop solutions to industrial problems. Emphasis is given to the application of quality management techniques to solve industrial case problems. The course emphasizes the philosophy and fundamentals of quality control, the statistics foundations of quality control, statistical process control, acceptance sampling, and product and process design. Prerequisites: STAT 230 and MECH 421.

MECH 622 Advanced Manufacturing Processes [3 cr.]

MECH 624 Mechanics of Composite Materials [3 cr.]
A course on anisotropic elasticity and laminate theory, analysis of various members of composite materials, energy methods, failure theories, and micromechanics. Materials and fabrication processes are introduced. Prerequisites: MECH 320 or CIVE 310 and MECH 340 or equivalents.

MECH 625 Fatigue of Materials [3 cr.]
A course that deals with high cycle fatigue, low cycle fatigue, S-N curves, notched members, fatigue crack growth, cycling loading, Manson-Coffin curves, damage estimation, creep and damping. Prerequisite: MECH 320 or CIVE 310.

MECH 626 Metals and their Properties [3 cr.]
A course that investigates ferrous and non-ferrous alloys, industrial equilibrium diagrams, heat treatment of metals, surface properties of metals, plastic deformation of metals, elements of fracture mechanics, process-structure-properties relations. Prerequisite: MECH 340.

MECH 627 Polymers and their Properties [3 cr.]
A course on chemistry and nomenclature, polymerization and synthesis, characterization techniques, physical properties of polymers, viscoelasticity and mechanical properties, applications. Prerequisite: MECH 440.
MECH 628 Design of Mechanisms [3 cr.]
A course involving graphical and analytical synthesis of single- and multi-loop linkage mechanisms for motion, path, and function generation through 2-3-4- and 5 precision positions, optimum synthesis of linkage mechanisms, synthesis of cam-follower mechanisms, synthesis of gear trains. Prerequisite: MECH 332.

MECH 630 Finite Element Methods in Mechanical Engineering [3 cr.]
A course on the classification of machine components, displacement-based formulation, line elements and their applications in design of mechanical systems, isoparametric formulation, plane stress, plane strain, axi-symmetric, and solid elements and their applications, modeling considerations and error analysis, introduction to ALGOR general formulation and Galerkin approach, analysis of field problems. Prerequisites: MECH 420 and MECH 435.

MECH 631 Micro Electro Mechanical Systems [MEMS] [3 cr.]
A course that deals with materials for micro-sensors and micro-actuators, materials for micro-structures, microfabrication techniques and processes for micromachining, computer-aided design and development of MEMS, commercial MEMS structures and systems, packaging for MEMS, future trends, and team project. Prerequisite: MECH 430.

MECH 633 Biomechanics [3 cr.]
A course on the study of the biomechanical principles underlying the kinetics and kinematics of normal and abnormal human motion. Emphasis is placed on the interaction between biomechanical and physiologic factors (bone, joint, connective tissue, and muscle physiology and structure) in skeleto-motor function and the application of such in testing and practice in rehabilitation. The course is designed for senior level undergraduate/graduate engineering students with no previous anatomy/physiology. Prerequisite: CIVE210, MECH 320, or CIVE 310, or approval of instructor.

MECH 634 Biomaterial and Medical Devices [3 cr.]
Course that examines the structure-property relationships for biomaterials and the medical applications of biomaterials and devices. The first part of the course focuses on the main classes of biomaterials, metal, ceramic, polymeric, and composite implant materials, as well as their interactions with the human body (biocompatibility). The second part of the course examines the various applications of biomaterials and devices in different tissue and organ systems such as orthopedic, cardiovascular, dermatology, and dental applications. Experts from the medical community will also be invited to discuss the various applications. Prerequisite: MECH 340 or consent of instructor.

MECH 641/EECE 661 Robotics [3 cr.]
A course discussing concepts and sub-systems; robot architecture; mechanics of robots: kinematics and kinetics; sensors and intelligence; actuators; trajectory planning or end effector motion; motion and force control of manipulators; robot languages. Prerequisites: MECH 332 and MECH 435.

MECH 642 Computer Vision [3 cr.]
An introductory course on the problems and solutions of modern computer vision. Topics covered include image acquisition, sampling and quantisation; image segmentation; geometric framework for vision: single view and two-views; camera calibration; stereopsis; motion and optical flow; recognition; pose estimation in perspective images. Prerequisites: math 202 and EECE 230.

MECH 643 Mechatronics and Intelligent Machines Engineering II [3 cr.]
A course on sensors, sensor noise and sensor fusion, actuators, system models and automated computer simulation, information, perception, and cognition, planning and control, architecture, design, and development, team project. Prerequisites: MECH 340 and MECH 530.
MECH 644 Modal Analysis [3 cr.]
A course reviewing MDOF system vibrations, frequency response functions, damping, mobility measurement, curve fitting and modal parameter extraction, derivation of mathematical models, laboratory experiments, and projects. Prerequisite: MECH 531.

MECH 645 Noise and Vibration Control [3 cr.]
A course on fundamental concepts in noise and vibration, passive and active damping strategies, damping materials, control methods, applications. Prerequisites: MECH 230, math 212, and MECH 531. Alternate years.

MECH 645 Noise and Vibration Control [3 cr.]
A course on fundamental concepts in noise and vibration; passive and active damping strategies; damping materials; control methods; applications. Prerequisites: MECH 230, math 212, and MECH 531. Alternate years.

MECH 647 Hydraulic Servo Systems [3 cr.]
A graduate lecture course which teaches the fundamentals of modeling and control of hydraulic servo-systems. It provides theoretical background and practical techniques for the modeling, identification and control of hydraulic servo-systems. Classical and advanced control algorithms are discussed. The use of Matlab/Simulink and DYMOLA will be an integral part in this course. Prerequisites: MECH 314 and MECH 435.

MECH 648 Nonlinear Systems: Analysis, Stability, and Control [3 cr.]
This course presents a comprehensive exposition of the theory of nonlinear dynamical systems and its control with particular emphasis on techniques applicable to mechanical systems. The course will be punctuated by a rich set of mechanical systems examples, ranging from violin strings vibration to jet engines, from heart beats to vehicle control, and from population growth to nonlinear flight control. Prerequisite: MECH 433 Control Systems or equivalent. Alternate years.

MECH 660 Advanced Fluid Mechanics [3 cr.]
A course that examines fundamental concepts and principles in addition to basic relations for continuous fluids; Vorticity dynamics, Kelvin-Helmholtz theorems; Navier-Stokes equations; and turbulence and oscillating flows. Prerequisite: MECH 314.

MECH 663 Computational Fluid Dynamics [3 cr.]
A course that deals with discretization process in fluid dynamics, numerical approaches and applications, interactive and direct matrix methods, numerical implementation of turbulence models. Prerequisites: MECH 314 and MECH 412.

MECH 665 Unsteady Gas Flow [3 cr.]
A course examining equations of unsteady continuous adiabatic multidimensional flows, unsteady continuous one-dimensional flow of a perfect gas with and without discontinuities, applications, pressure exchangers. Prerequisite: MECH 414.

MECH 670 Laboratory for Renewable Energy in Buildings [2 cr.]
A laboratory course that will investigate means of reducing building energy consumption first through green building design, giving consideration to building orientation, thermal massing, wind- and buoyancy- driven flows, “urban heat island” effects, and second, by retrofitting existing buildings with energy saving materials and devices such as window films, solar water heaters, and green roofs. This course is offered because in Lebanon and the region, electricity consumption for building services accounts for a major portion of national energy use and greenhouse gas emissions. Students will measure and compare effects of various designs and retrofit interventions on the thermal performance, lighting and glare, and natural ventilation of model-scale buildings, and characterize performance of devices used in green building design. Lab assignments may vary by semester but will normally
include mathematical modeling and experimental measurement components organized around aspects of building physics. Prerequisite: MECH 430.

The course covers the principles and utilization of solar (thermal and photovoltaic), wind, and geothermal energy, as well as energy from biomass. Issues relevant to energy efficiency and energy storage are discussed (heat and power store and bio-tanks). The course distinguishes between energy sources for large-scale, industrial/commercial settings and those intended for smaller structures. The potential of using renewable energy technologies as a complement to, and, to the extent possible, replacement for conventional technologies, and the possibility of combining renewable and non-renewable energy technologies in hybrid systems are analysed. Design aspects of active, passive, wind, bio-energy and photovoltaic energy conversion systems for buildings. Strategies for enhancing the future use of renewable energy resources are presented. The course will include several demonstrations of concept experiments. Prerequisite: MECH 310. Students cannot receive credit for both MECH 671 and EECE 675.

MECH 672 Energy Systems Modeling [3 cr.]
Indoor space thermal models. Analysis and modeling of building energy systems involving applications of thermodynamics, economics, heat transfer, fluid flow and optimization. The use of modern computational tools to model thermal performance characteristics of components of HVAC systems including chillers, recovery systems, flow control devices, heat exchanges, solar panels, dehumidification systems, boilers, condensers, cooling towers, fans, duct systems, piping systems and pumps. The course will use extensively modern simulation tools. Prerequisite: MECH 310.

MECH 673 Energy Efficient Buildings with Good Indoor Air Quality [3 cr.]
The course covers energy consumption standards and codes in buildings; energy conservation measures in built in environment to enhance the building’s energy efficiency while maintaining space thermal comfort and indoor air quality requirement; fundamental ventilation, indoor-air-quality, infiltration natural and mechanical ventilation, importance and impact of indoor air quality on human health and energy performance of the building air conditioning system; and ASHRAE requirement for ventilation. Particular focus will be given to green energy alternative measures. An overview of the different heating, ventilation and air conditioning system designs is covered. Performance and energy consumption of the conventional air conditioning system (constant and variable air volume) as well as the hybrid integrated air conditioning systems will be discussed and compared. The course will include several demonstrations of concept experiments. Prerequisite: MECH 310.

MECH 674 Energy Economics and Policy [3 cr.]
This course aims to develop an understanding and practical analytical skills of energy economics and planning approaches taking into account the cost of impact on the environment. This course will provide fundamental concepts of economic issues and theories related to energy, such as economics of natural and energy resources, aggregate supply and demand analysis, and the interrelationship between energy, economics and the environment as well as some important issues in energy policy. The course will also demonstrate the use of economic tools for decision making in energy and environment planning and policy. It will explore the terminology, conventions, procedures and planning policy applications. It will also cover a number of contemporary energy and environmental policy issues, including energy security, global warming, regulations of energy industries, energy research and development, and energy technology commercialization. Prerequisite: ENMG 400.

MECH 675 Building Energy Management Systems [3 cr.]
The course provides an opportunity for students to explore topics in energy management systems and management strategies for new and existing buildings. Energy use in buildings, energy systems analysis and methods for evaluating the energy system efficiency. Energy
audit programs and practices for building and facilities, initiating Energy management program, guidelines for methods of reducing energy usage in each area in buildings, conservation of the energy in the planning, design, installation, utilization, maintenance, control and automation of the mechanical systems in existing and new buildings, of air conditioning and ventilation systems in buildings. Assessment and optimization of energy control strategies. Prediction methods of economic and environmental impact of implemented control strategies and indoor settings. Prerequisite: MECH 310 and MECH 412.

MECH 676 Passive Building Design [3 cr.]
This course centers on issues surrounding the integration of Sustainable and passive design principles, into conceptual and practical Building design. Topics will include: solar geometry, climate/regional limitations, natural lighting, passive design and sustainability initiatives, insulating and energy storing material. Bioclimatic design and concepts. Case studies will be used extensively as a vehicle to discuss the success/failure of ideas and their physical applications. The course will focus on the use energy auditing/modeling methods as means to both design and evaluate the relative "greenness" of buildings, as well as to understand the global implications of sustainable buildings. The course will include several demonstrations of concept experiments. Prerequisite: MECH 671.

MECH 677 Heat pumps [3 cr.]
eat pumps in low energy and passive buildings. Ground source Heat Pump fundamentals, loop Systems, open Systems, soil/rock classification and conductivity, grouting procedures, performance of ground source heat pumps in housing units. Water loop heat pumps, inside the building, bore holes, design and optimization of heat pump plants, including heat sources for such plants are considered in detail. Cost effective design options. The course includes study visits and seminars given by industry experts. Prerequisite: MECH 310.

MECH 678 Solar Electricity [3 cr.]
The solar cell: photogeneration of current, characteristic current-voltage (I-V) curve, equivalent circuit, effect of illumination intensity and temperature. The Photovoltaic (PV) generator: characteristic I-V curve of a PV generator, the PV module, connections of modules, support, safeguards, shadowing. The PV system: batteries, power conditioning. PV Systems: grid- connected and stand-alone systems, economics and sizing, reliability, applications. Manufacturing: preparation of crystalline silicon wafers, formation of contacts, coatings, construction of modules. The course will include several demonstrations of concept experiments. Prerequisite: EECE 210.

MECH 679 Energy Audit Lab [2 cr.]
A course that is designed to give the students “hands-on” experience with carrying out energy audit measurements and studies on buildings to identify possible savings through selected energy conservation measures. The students will carry out measurements to investigate ventilation, air conditioning equipment, lighting and other office and lab equipment. The students will then be introduced to Visual DOE or E-Quest to perform energy simulation of buildings. Such tools will then be used to carry out a full building simulation taking into consideration occupancy data, equipment, lights, and building envelope. A base case of energy usage will thus be established and energy conservation is then applied to deduce possible savings and their economic value. Pre- or co-requisite: MECH 672.

MECH 701 Principles of Combustion [3 cr.]
A course on gas-phase reaction mechanisms and thermo-chemical kinetics; theory of ignition, flame propagation, and detonation; characteristics of premixed, diffusion, laminar, and turbulent flames; combustion aerodynamics; liquid and solid fuels in practical systems; pollutant formation and reduction mechanisms. Prerequisite: CHEM 202, MECH 414, MECH 412, or equivalents.

MECH 702 Pollutant Formation and Control in Combustion [3 cr.]
Fundamentals of gas and condensed phase pollutant formation, measurement, and control pertaining to practical combustion systems. Topics include heat and mass transfer in reacting systems, chemical reaction kinetics, particle coagulation kinetics, and flame structure and propagation. These fundamental subjects are applied in the study of pollutant formation and control in practical systems including internal combustion engines, jet engines, and industrial boilers. Removal of gaseous and particulate pollutants from effluent streams by use of adsorption, absorption, catalytic processes, inertial separation, and electrostatic precipitators. Prerequisites: MECH 314, 414, 412, chem 202 or consent of instructor. May be repeated for credit when topics vary.

MECH 703 Combustion Modeling [3 cr.]
Topics include chemical thermodynamics and chemical kinetics, conservation laws for reacting flow problems, diffusion controlled vs. chemistry controlled combustion, Laminar non-premixed and premixed flames and jets multi-phase combustion, detonations waves, turbulent combustion, and combustion stability. Prerequisites: CHEM 202, MECH 414, MECH 412 or equivalents.

MECH 707 Statistical Mechanics and Thermodynamics [3 cr.]
This course examines the basic principles of statistical mechanics and their relation to the laws of thermodynamics and the concepts of temperature, work, heat, and entropy; the microcanonical, canonical, and grand canonical distributions; the applications to lattice vibrations, ideal gas, photon gas, quantum statistical mechanics; the Fermi and Bose systems, interacting systems. Prerequisite: MECH 310.

MECH 720 Advanced Machine Design [3 cr.]
A course that involves the analysis of stress and strain, torsion, design of axi-symmetrically loaded members, beams on elastic foundations, elastic stability, surface contact and wear, impact, and finite element applications to nonlinear problems. Prerequisite: MECH 520.

MECH 721 Elasticity and Plasticity [3 cr.]
A course on tensor analysis, the general state of stresses, properties and deformation of solid materials, elasticity, plasticity, matrix methods, and applications. Prerequisite: MECH 320 or GIVE 310.

MECH 729 Spatial Mechanisms [3 cr.]
A course that covers position, velocity, and acceleration analysis of spherical and spatial mechanisms; isometry; geometry of rotation axes; finite position synthesis, the 4R spherical linkage; lines and screws; the RSSR, RSSP, 4C, and 5TS spatial linkages; platform manipulators. Prerequisite: MECH 628.

MECH 736 Modeling Solidification Processes [3 cr.]
The course seeks to impart a coherent view of solidification processes and how they are modeled. Topics for the first part of the course include: homogeneous and heterogeneous nucleation, with plane front, cellular and dendritic pattern, columnar and equiaxed grain growth. Phenomena affecting the quality of castings such as micro-segregation, constituent under-cooling, macro-segregation and porosity formation are also covered. In the second part solidification models are developed and applied in the context of casting operations. The course covers: heat flow in solidification processes; thermodynamics of solidification: nucleation and growth; binary phase diagrams, phase diagram computation; microstructure evolution, constitutional under-cooling; columnar and equiaxed solidification enthalpy method; mushy zone modeling; phase-field method; volume-averaging of conservation equations; multi-scale models; modeling solidification defects. Prerequisite: MECH 340, MECH 420, or consent of instructor.

MECH 740 Advanced Dynamics [3 cr.]
Appendix I >> Course Description

A course that examines three-dimensional kinetics and kinematics, theory of rotating axis, Hamilton's equations, Lagrange's equation, and Euler's equations. Prerequisite: MECH 230 or equivalent.

MECH 746 Space Mechanisms [3 cr.]
Topics covered are mobility, spatial displacements, formulation of the kinematic equation, analysis and synthesis of spherical mechanisms, analysis and synthesis of spatial mechanisms, optimum synthesis of spherical and spatial kinematic chains, and analysis of platform manipulators. Prerequisite: MECH 628.

MECH 747 Nonlinear Finite Element Analysis [3 cr.]
Governing equations and geometric and material nonlinearities; Formulation of nonlinear problems; solution algorithms: vector and matrix methods; direct and iterative equations solvers; FE Methods for nonlinear mechanics; Element technology; Numerical implementation of constitutive models; pitfalls of nonlinear analysis; Prerequisite: MECH 630.

MECH 751 Simulation of Multiphase Flows [3 cr.]
Multiphase flows are important to many engineering and environmental applications. This course is intended to give an overview of the fundamentals involved in dispersed multiphase flows, and develop a working knowledge which would allow the student to numerically predict these flows. The course examines: The conservation equations for multiphase systems. Discretization using the finite-volume method. Pressure-based algorithms for multi-fluid flow at all speeds: Mass Conservation Based Algorithms and Geometric Conservation Based Algorithms [SIMPLE, SIMPLEX, PISO, etc.]. The partial elimination and SINCE algorithms. Weighted pressure correction. Mutual influence of volume fractions. Implicit volume fraction equations. Bounding the volume fractions. Numerical implementation. Applications. Prerequisite: MECH 663.

MECH 760 Advanced Fluid Mechanics [3 cr.]
A course that examines fundamental concepts and principles, basic relations for continuous fluids, vorticity dynamics, Kelvin and Helmholtz theorems, Navier-Stokes equations, turbulent and oscillating flows. Prerequisite: MECH 314 or equivalent.

MECH 761 Convection Heat Transfer [3 cr.]
A course that covers fundamental modes of heat transfer; similarity between heat, momentum, and mass transfer in forced and buoyancy-driven flows; simultaneous heat, momentum, and mass transfer with phase change. Prerequisites: MECH 314 and MECH 412.

MECH 762 Advanced Thermodynamics [3 cr.]
A course on advanced thermodynamic concepts; gas mixtures and multi-phase systems; chemical reactions; thermodynamic property relations; chemical and phase equilibrium; applications. Prerequisite: MECH 414.

MECH 763 Radiative Heat Transfer [3 cr.]
Principles of thermal radiation and their application to engineering heat and photon transfer problems. Quantum and classical models of radiative properties of materials, electromagnetic wave theory for thermal radiation, radiative transfer in absorbing, emitting, and scattering media, and coherent laser radiation. Applications cover infrared instrumentation, global warming, furnaces, and high temperature processing. Prerequisite: MECH 412.

MECH 764 Advanced Topics in Computational Fluid Dynamics [3 cr.]
A course on numerical solution of compressible unsteady flows; advanced turbulence modeling; the segregated approach; the multigrid technique; introduction to multi-phase flows. Prerequisite: MECH 663.
MECH 765 Advanced Finite Volume Techniques [3 cr.]
Linear Multigrid; Non-Linear Multigrid; Mesh Agglomeration: structured and unstructured grids; Mesh generation: structured and unstructured grids. Free Surface Simulation. Prerequisite: MECH 411.

MECH 766 Turbulent Flow and Transport [3 cr.]

MECH 767 Heat Conduction [3 cr.]

MECH 768 Transport through Porous Media [3 cr.]
The course is designed for graduate students interested in the flow of multi-phase, multi-component fluids through porous media. The course emphasizes physics of the momentum, heat and mass transport formulation and computations in multi-dimensional systems, including theoretical models of fluid flow, capillary effects, application of fractal and percolation concepts, characterization of porous materials, multiphase flow and heat transfer, turbulent flow and heat transfer, improved measurement techniques, and enhanced design correlations. Prerequisite: MECH 412.

MECH 769 Advanced Scientific Computing [3 cr.]
High-performance scientific computing is an exciting and rapidly-changing field. In this course students will learn how to solve and visualize large-scale continuum type problems using high-performance cluster-type computing systems. Sections of the course will concentrate on discretization methods multigrid methods in a parallel computing context. Different parallel computing paradigms are introduced with emphasis on domain decomposition methods, and the practical aspects of their implementations using MPI. Prerequisite: Prior knowledge of C programming and familiarity with the UNIX operating system.

MECH 771 HVAC System Control Strategies and Energy Efficiency [3 cr.]
This course deals with the most common control strategies based on temperature set point, PMV control, CO2 set-point, and equipment used to reduce the amount of energy consumed by heating, ventilating, and air conditioning (HVAC) systems using non-derivative optimization techniques. Control strategies and technologies related to gaseous indoor air pollutants. The control strategies analyzed in the course are: scheduled start-stop, day-night setback, optimum start-stop, dead band control, duty cycling, demand limiting and load shedding, economizer and enthalpy cycles, scheduled temperature reset, chiller control and chilled water reset, boiler control and hot water temperature reset, and condenser water temperature reset. Recent developments in HVAC control system hardware, such as pneumatic systems, electro-pneumatic systems, digital-electronic systems, and microcomputer-based control systems, are also discussed. The strategies are studied and compared to each other in terms of cost effectiveness using optimization techniques. Case studies are used to strengthen understanding. Prerequisite: MECH x02 and MECH 433.

MECH 772 Moisture and Control of Humidity Inside Buildings [3 cr.]
Sources of moisture and factors affecting its entry and buildup inside the buildings such as construction practices and choice of building materials and furniture. Impact of moisture on thermal comfort and energy performance of the air-conditioning system. Solid/liquid desiccant dehumidification and hybrid air-conditioning systems. Modeling of moisture transport. Industrial need to control indoor humidity. Moisture-caused health issues
including mold formation and growth. The course will include several demonstrations of concept experiments. Prerequisite: MECH 672.

MECH 773 Numerical Methods in Energy Technology [3 cr.]
A course that introduces the fundamentals of numerical methodology in energy related area (CFD, Heat and mass transfer). Topics include: basic conservation equations; boundary conditions; finite volume discretization of conservation equations; geometry and computational mesh discretization practices; turbulence modeling (k-two-equation model); SIMPLE and SIMPLEC algorithms; thermal and solar radiation; and dispersed multiphase flow. The course emphasizes how to apply this information to the design and testing of related equipment. Individual and group assignments are given throughout the course to act as training aid and to enhance understanding. A class project is included to provide supervised practice on course material using commercial software. Prerequisite: MECH 672.

MECH 778 Special Projects on Renewable Energy Systems Design [3 cr.]
This course allows the student to take a given set of requirements and to select and design a complete renewable energy system to fully meet those requirements. The student will perform all aspects of the project design from cost-benefit analysis to systems specification to construction, control and final audit assessment of the completed energy system. The student is exposed to various commercially available design and simulation software for planning, specifying and simulation testing of renewable energy retro-fits and new installations. Prerequisites: MECH 671 and MECH 672.

a1.3 description of Applied Energy lab courses

MECH 670 Laboratory for Renewable Energy in Buildings [2 cr.]
In Lebanon and the region, electricity consumption for building services accounts for a major portion of national energy use and greenhouse gas emissions. In this laboratory course, we will investigate means of reducing building energy consumption first through green building design, giving consideration to building orientation, thermal massing, wind- and buoyancy-driven flows, “urban heat island” effects, and second, by retrofitting existing buildings with energy saving materials and devices such as window films, solar water heaters, and green roofs. Students will measure and compare effects of various design and retrofit interventions on the thermal performance, lighting and glare, and natural ventilation of model-scale buildings, and characterize performance of devices used in green building design. Lab assignments may vary by semester but will normally include mathematical modeling and experimental measurement components organized around aspects of building physics. Prerequisite Advanced standing, MECH 430.

MECH 679 Energy Audit Lab [2 cr.]
This course is designed to give the students “hands-on” experience with carrying out energy audit measurements and studies on buildings to identify possible savings through selected energy conservation measures. The students will carry out measurements to investigate ventilation, air conditioning equipment, lighting and other office and lab equipment. The students will then be introduced to Visual DOE or E-Quest to perform energy simulation of buildings. Such tools will then be used carry a full building simulation taking into consideration occupancy data, equipment, lights, and building envelope. A base case of energy usage will thus be established and energy conservation are then applied to deduce possible savings and their economic value. Pre-or co-requisite

MECH 770 HVAC and Refrigeration Systems Lab [2 cr.]
This course is designed to give the students “hands-on” experience with building energy systems and expose them to basic and advanced methods of measurements and data analysis to design, test, and evaluate indoor climate conditions and HVAC systems’ performance under appropriate control strategies for comfort and indoor air quality. The students will learn how to use and develop test equipment and plan for assessing system's performance according to ISO or ASHRAE standards. The students will be exposed to electrical HVAC
Appendix I >> Course Description

Instrumentation and hardware, IAQ testing equipment, tracer gas techniques for ventilation rates measurements, flow characterization measurements and air leakages and fenestration ratings. Experiments and lab projects will span a series of advanced modules on sustainable, energy-efficient HVAC and refrigeration systems as laboratory topics. Lab topics may vary every semester. Prerequisite or corequisite MECH 673.


MECH 796 Special Projects in Mechanical Engineering [3 cr.]

A seminar that consists of weekly presentations on current research or applied projects in mechanical engineering presented by faculty, students, and invited scholars. This is a pass-fail course based on attendance.

MECH 797 Seminar [0 cr.]

A seminar that consists of weekly presentations on current research or applied projects in mechanical engineering presented by faculty, students, and invited scholars. This is a pass-fail course based on attendance.

MECH 798 Special Topics in Mechanical Engineering [3 cr.]

MECH 798A Fundamentals of Energy and Resource Recovery [1 cr.]

Combustion and the environmental impact of combustion, Fundamentals in energy and material balances, Basic knowledge of the kinetics and the influence of different flow models. Humidification and vapor liquid equilibrium. Prerequisite: MECH 310.

MECH 798B Energy Recovery [1 cr.]

The aim of the course is to give the students extended knowledge on various techniques for energy recovery by combustion. Topic include combustion devices, fluidized bed boilers, grate boilers, biogas boilers, energy recuperation and recovery technology, effects of inorganic compounds in the fuel, fuel and ash treatment, fouling and agglomeration. Fundamental of metals, oxidation phenomena, high temperature corrosion, and erosion-corrosion. Prerequisites: MECH 310 and MECH 340.

MECH 798C Sustainable Materials [1 cr.]

The aim of the course is to give the student knowledge regarding sustainable materials, and use this in product and process development to meet the target of achieving sustainability in the society. The course covers the development and economy of industrial materials. Materials and environment, and materials and public health. Alternative materials strategies: recycling and reuse, advanced and engineered materials, renewable materials, bio-based materials. Concepts for sustainable materials: dematerialization and detoxification. Legislation and governmental policies. Project work on a case study. Prerequisite: MECH 340.

MECH 798D Moisture Transport in Building Envelopes [2 cr.]

Sources of moisture affecting building envelops; rain, water vapor in outside and inside air, condensation and water uptake from the foundation. Factors affecting the entry and buildup of moisture such as construction practices, choice of building materials and surface treatments. Impact of moisture on heat transport through the envelops. Modeling of moisture transport. Moisture-caused damages including mould growth, decay of construction materials paintings etc. Prerequisite: MECH x02.

MECH 798E Computer Modeling and Building Physics Applications [2 cr.]

Computer modeling of temperature and moisture conditions in building materials and components is essential in order to evaluate the performance of the building envelope, which is decisive both for the indoor climate, the consumption of energy, and the durability of the construction. These are important factors for low environmental impact and sustainable building technology. Focus will be given on understanding and use of computer models for building physics applications. Theory of mathematical and numerical modeling of heat and
mass transfer and an overview of existing calculation tools combined with practical exercises will be given. A simple calculation tool will also be developed within this course.

MECH 798F Contemporary Topics in Energy Management [2 cr.]
This course provides students with the basics of the interrelationships between energy, economy, and the environment. It highlights the global and regional energy scenes. The module provides students with the fundamentals of energy and carbon accounting, energy management, and energy efficiency. It will cover policies and measures to shift towards low carbon economy, and demonstrate approaches used in assessing these measures. Prerequisite: MECH 310.

MECH 799 (A-E) Thesis in Mechanical Engineering [6 cr.]

MECH 799T and MECH 799TR Master’s Comprehensive Exam [0 cr.]
The master’s degree comprehensive exam grading mode is Pass/Fail. If a student fails MECH 799T s/he must register for MECH 799TR and take the exam during the next term excluding summer.

MECH 898 Advanced Topics in Mechanical Engineering [3 cr.]

MECH 900 and 900A PhD Comprehensive Exam [0 cr.]
The PhD comprehensive exam grading mode is Pass/Fail. If a student fails MECH 900 s/he must register for MECH 900A.

MECH 991 PhD Dissertation [3 cr.]

MECH 992 PhD Dissertation [6 cr.]

MECH 993 PhD Dissertation [9 cr.]

MECH 998 and 998A PhD Defense of Thesis Proposal [0 cr.]
The defense of the PhD thesis proposal has a grading mode of Pass/Fail. If a student fails MECH 900 s/he must register for MECH 900A. Prerequisite: MECH 900 or MECH 900A with a pass.

MECH 999 and 999A PhD Thesis Defense [0 cr.]
The PhD thesis defense has a grading mode of Pass/Fail. If a student fails MECH 999 s/he must register for MECH 999A. Prerequisite: MECH 998 or MECH 998A with a pass.
## Important Phone Numbers

<table>
<thead>
<tr>
<th>Name</th>
<th>Phone 1</th>
<th>Department</th>
<th>Phone 2</th>
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</thead>
<tbody>
<tr>
<td>Prof. Marwan Darwish</td>
<td>3595</td>
<td>ME Department</td>
<td>3590/1</td>
</tr>
<tr>
<td>Prof. Nesreen Ghaddar</td>
<td>3594/2513</td>
<td>FEA Dean's Office</td>
<td>3400</td>
</tr>
<tr>
<td>Prof. Fadl Moukalled</td>
<td>3406</td>
<td>Mechanical Engineering Labs</td>
<td>3626</td>
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<tr>
<td>Prof. Kamel Ghaali</td>
<td>3438</td>
<td>Engineering Shops</td>
<td>3650</td>
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<tr>
<td>Prof. Ramsey Hamade</td>
<td>3481</td>
<td>Engineering Library</td>
<td>2630/2633</td>
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<tr>
<td>Prof. Albert Kuran</td>
<td>3473</td>
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<td>2570</td>
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<td>Prof. Alan Shihadeh</td>
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<td>Prof. Daniel Asmar</td>
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<td>Prof. Issam Lakkis</td>
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<td>Prof. Ghanem Oweis</td>
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<td>Prof. Mutassem Shehadeh</td>
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<td>Prof. Salem Seifeddine</td>
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### Chemical Engineering Program

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<tr>
<td>Prof. Mahmoud Al Hindi</td>
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<td>Prof. Fouad Azizi</td>
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<td>Prof. Walid Saad</td>
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<td>Prof. Joseph Zeaiter</td>
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## American University of Beirut
### Faculty of Engineering and Architecture
#### Department of Mechanical Engineering
**Master of Engineering [ME] Proposed Program of Study**

<table>
<thead>
<tr>
<th>Student No.</th>
<th>Name</th>
<th>Major</th>
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<tr>
<th><strong>Background Courses</strong></th>
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<tr>
<th><strong>Course Taken or To Be Taken</strong></th>
<th>At AUB to Count Towards Degree</th>
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**Total Semester Hour Credit to be Counted Towards Degree**

Total semester hours including thesis:  
- 800 level
- 700 level
- 600 level

**Proposed Thesis Title:**

**Approved Thesis Committee**

- **Chairperson**
  - Date
- **Member**
  - Date
- **Member**
  - Date
- **Member**
  - Date
- **Member**
  - Date
- **Departmental Chairperson**
  - Date
- **Chairperson of Graduate Studies Committee**
  - Date
# American University of Beirut

**Faculty of Engineering and Architecture**

**Department of Mechanical Engineering**

**Doctor of Philosophy Program of Study**

<table>
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<tr>
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<th><strong>COURSE DESCRIPTION</strong></th>
<th><strong>WHERE TAKEN</strong></th>
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**COURSE TAKEN OR TO BE TAKEN** at AUB and are Required for the Degree

**CORE: MATH**

**CORE: BREADTH REQUIREMENT**

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<th><strong>THESIS</strong></th>
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**TOTAL Semester Hour Credit to be Counted Towards Degree**

Total semester hours including thesis: 800 level 700 level 600 level Math at 300 level

**PROPOSED THESIS TITLE:**

**APPROVED THESIS COMMITTEE:**

<table>
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<tr>
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<th>DEPARTMENTAL CHAIRPERSON</th>
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<th>CHAIR OF IEA GRADUATE STUDIES COMMITTEE</th>
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<tr>
<th>CHAIR OF BOARD OF GRADUATE STUDIES</th>
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**ALL SIGNATURES VERIFY APPROVAL OF TOTAL FORM**
The topics covered in the exam are related to senior years of the ME undergraduate program and are grouped into seven areas. From the list of seven areas listed below, please select [by checking the corresponding box] the four topics you intend to examined in.

- Thermodynamics
- Fluid Dynamics
- Heat Transfer
- Mechanical Design
- Systems Dynamics and Control
- Materials and Manufacturing
- Applied Mechanics

**Applicant Signature**

**Date**

**Final Grade [For department use only]**

- Pass
- Conditional Pass
- Fail

**Chairperson of Department/Program**

**Date**
AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
GRADUATE STUDIES
THESIS PROPOSAL FORM

Major: 
Student’s Name: 
Proposal Title: 

Graduate Advisor: 
Committee Members: 1. 
2. 
3. 

Date Submitted: 

APPROVAL:

CHAIRPERSON OF DEPARTMENT ____________________ DATE __________

COMMITTEE MEMBERS:

COMMITTEE CHAIRPERSON ____________________ DATE __________ COMMITTEE MEMBER ____________________ DATE __________

COMMITTEE MEMBER ____________________ DATE __________ COMMITTEE MEMBER ____________________ DATE __________

TENTATIVE DATES FOR

Comprehensive Exam: ____________________ Thesis Defence: ____________________ Graduation: ____________________
AMERICAN UNIVERSITY OF BEIRUT
GRADUATE RESEARCH ASSISTANTSHIP APPLICATION

To: __________________________  __________________________  __________________________  __________________________
FIRST NAME  FATHER'S NAME  FAMILY NAME  STUDENT NO.

The Department of __________________________ in the Faculty __________________________ has agreed to grant you a
Graduate Research Assistantship for the Academic year __________________________.

<table>
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<tr>
<th>Semester</th>
<th>From:</th>
<th>To:</th>
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<td>Fall Semester</td>
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<td>Spring Semester</td>
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<tr>
<td>Summer Session</td>
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</table>

The Assistantship is granted on a

- [ ] Full Support basis of 20 hours per week.
- [ ] Partial Support basis of 10 - 15 hours per week, as set by Faculty Policy.

As a Graduate Research Assistant, your assistantship involves a commitment on your part to assist faculty
members in their research.

You shall receive a monthly stipend of LL_________________________. In view of the fact that this assistantship
constitutes part of your education, the university shall provide free tuition for course instruction up to a maximum
of ____________ credit hours for the Fall or Spring Semester/Summer Session.

It is agreed and understood that

1) you as a full-time student awarded Graduate Research Assistantship may not work
   more than 20 hours per week in this capacity,
2) you are not allowed to work outside the university, and
3) shall not also receive other financial aid as long as this Assistantship is in force.

Furthermore, this assistantship may be terminated with one month’s notice at any time.
that your performance as a student and/or Graduate Research Assistant is
considered at the sole discretion of the department concerned to be unsatisfactory.

________________________
SIGNATURE OF STUDENT

________________________
SIGNATURE OF THE DEAN
OR AUTHORIZED OFFICER

DATE

DATE

Charge account number: ____________

cc: Dean’s Office
   Department concerned
   Office of Student Affairs
   Comptroller
# American University of Beirut

**Faculty of Engineering and Architecture**

**Petrofac Graduate Fellowship Application**

## TYPE ALL INFORMATION:

**NAME:**

**SURNAME NAME**

**FULL NAME[s]**

**STUDENT NO:**

**HOME ADDRESS:**

**POSTAL CODE:**

**NOTE:** For current graduate students, all correspondence about this application will be sent to the Mechanical Engineering Department.

## PRESENT OR INTENDED AUB DEGREE PROGRAM | DEPARTMENT

<table>
<thead>
<tr>
<th>SEMESTER OF ACTUAL OR INTENDED ENTRY TO THIS DEGREE PROGRAM</th>
<th>POST-SECONDARY EDUCATION INCLUDING PRESENT PROGRAM [ATTACH TRANSCRIPTS]</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTITUTION</td>
<td>LOCATION</td>
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</tbody>
</table>

## NUMBER OF SCHOLARLY PUBLICATIONS: [provide a list on page 2.]

## SEMESTERS OF SUPPORT REQUESTED:

- [ ] Fall
- [ ] Spring
- [ ] Summer

I declare all information provided by me to be true and agree to abide by the terms of reference of the award if this application is approved. The information will be used to determine the best candidates for fellowship. [If you have any questions about the collection and use of this information, please write to the office of the Dean].

**APPLICANT SIGNATURE**

**DATE**

Pages 1 and 2 of the completed application and all post-secondary transcripts must be received by the Department of intended enrolment at AUB by November 30.

This section is to be completed by the Department Chair. If the applicant is not recommended for support leave this section blank and sign on page 2.

**A-List: Applicant is recommended for support in the following semesters:**

- [ ] Fall
- [ ] Spring
- [ ] Summer

**B-List: Applicant is ranked: # for support in the following semesters:**

- [ ] Fall
- [ ] Spring
- [ ] Summer

Department Chair should sign on page 2.